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Lost in Transactions: Analysing the Institutional Arrangements Underpinning Urban Green Infrastructure

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ABSTRACT

Urban development has altered surface-water hydrology of landscapes and created urban heat island effects. With climate change, increasing frequency of extreme heat events and in some areas, episodic drought and flooding, present new challenges for urban areas. Green infrastructure holds potential as a cost-effective means of providing microclimate cooling and stormwater diversion. Further, green open spaces when combined with the provision of equipment and facilities have the potential to promote physical and emotional well-being. However successful implementation may be predicated on co-ordinated efforts of multiple agencies. The Institutional Analysis and Development framework developed by Crawford and Ostrom is used in a case study to understand the institutional impediments, transaction costs and gaps in responsibility associated with the delivery of green infrastructure. Lessons learned are potentially transferable to other urban settings. Our analysis reveals areas of high transaction costs as well as a gap in the polycentric decision-making of agencies. The local government council is concerned with the well-being of its residents but has limited financial capacity. None of the agencies who deliver green infrastructure have responsibility for facilitating the indirect or preventative health benefits. Thus, a co-ordination problem among agencies can lead to suboptimal investments in green infrastructure.

1. Introduction

Worldwide the increasing pressures of urbanisation (Schaffler and Swilling, 2013), chronic under-investment in urban infrastructure (Nandi and Gamkhar, 2013) and the changing frequency of extreme weather conditions (drought, flooding and sustained hot weather events) demand a reconsideration of how infrastructure and services are delivered. While there will always be a role for grey infrastructure (concrete and bitumen), a case can be made for green infrastructure (GI) as a potentially cost-effective solution while enhancing the provision of urban ecosystem services (Palmer et al., 2015; Mekala et al., 2015; Gómez-Baggethun and Barton, 2013; Tzoulas et al., 2007; Bolund and Hunhammar, 1999). GI is defined, for the purposes of this study, as any area within the urban environment dedicated to elements of green vegetation that mitigate the impacts of urbanisation and includes elements such as wetlands, tree canopies, parks/gardens, and large conservation zones, providing ecosystem services such as amenity, recreational values, habitat services as well as improvements in air and water quality (Tzoulas et al., 2007; Weber et al., 2006). Ecosystem services are increasingly recognised as the benefits from nature which make life worth living and defined broadly as provisioning (food and materials), regulating (mitigation of environmental conditions), cultural (aesthetic and psychological benefits) and supporting services which underlie all ecosystem services (Bateman et al., 2013).

GI projects are generally implemented at the scale of neighbourhood or local government planning area as part of the development of greenfield sites or redevelopment of existing land uses. By its nature, GI is a decentralised solution shaped by institutional arrangements which support or impede the delivery of localised services. In this article, our focus is on open space GI providing ecosystem services to people. Further, it is useful to employ a broader definition of GI that includes natural vegetation combined with equipment/facilities. A park with bike paths can provide multiple benefits with habitat services through native vegetation, water quality benefits from intercepting stormwater with permeable grassed areas as well as the recreational/health benefits (Brown et al., 2014).

The aim of this study is to identify the key institutional factors that contribute to the development of more livable urban spaces using an Australian case study. The study uses the Institutional Analysis and Development (IAD) framework and seeks to (1) understand the

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contextual conditions that shape GI including the policy environment, community attributes and physical and biological systems; (2) assess the extent of interactions/collaborations between different actors and type of decisions made with respect to GI management; (3) evaluate the effectiveness of the key actors with respect to different policy outcomes and the indicators used to assess these outcomes; and (4) to evaluate the potential gaps in responsibility and decision-making.

2. Methods

Numerous frameworks exist for evaluating planning and natural resource management encompassing social relationships and the physical environment. In the context of urban water, Hellström et al. (2000) proposed a systems analysis for examining sustainability indicators (health, social-cultural, economic, environmental and technical system operations). Management approaches (e.g. Ferreira and Otley, 2009) focus on internal performance criteria for managing within organisations. Social-ecological systems approaches have been proposed by Hoffman (2003) and Ostrom (2009). However all these approaches fall short in the degree to which the institutional setting and contextual nature of the problem have been incorporated. The Institutional Analysis and Development (IAD) framework (Crawford and Ostrom, 1995) provides an encompassing systems view of the policy/institutional setting, economic and social/cultural aspects interacting with the physical environment. The focus is on understanding the interconnected rules/norms within and between organisations in a societal context (Crawford and Ostrom, 1995). In particular, "frameworks serve as a meta-theoretical schema that facilitate the organization of diagnosis, analysis, and prescription" (Ostrom et al., 2017, p 51). The IAD framework is flexible and as a result has been applied widely in areas such as public health (Bailey, 2014), conservation programs (Morrison and Hardy, 2014), nanotechnology consortia (Allarakhia and Walsh, 2012) and immigration policy (Lam, 1997).

The IAD framework defines institutions as "enduring regularities of human action in situations structured by rules, norms, and shared strategies, as well as by the physical world" (Imperial, 1999, p 453). Institutions influence and are in turn, influenced by the broader policy environment, the attributes of the community and the bio-physical aspects of the geographical area. These combined conditions provide the contextual conditions of the analysis (see Fig. 1). Within this framework, the unit of analysis is the action arena/situation which includes individuals and organisations that make decisions. The researcher explores how a group of individuals (or organisations) confront a problem and the rules they adopt to address it (Imperial, 1999). Further, the researcher assembles contextual attributes, the 'rules-in-use', and patterns of interaction to explore hypotheses (Ostrom et al., 2017).

Although GI is one integrated ecological unit in principle, its management is segregated and divided among different actors based on institutional boundaries. Actors (e.g., local government, state government agencies) will have a regularised way of decision-making and a key question for researchers is how to uncover the knowledge the various actors have concerning the policies, individual agency actions and collaboration among actors (Ostrom et al., 2017). To this end, this study uses in-depth interviews to assess and test propositions concerning actions and outcomes (Ostrom et al., 2017). In particular, the effectiveness of the actors in delivering the outcomes can be measured by selected indicators including indicative transaction costs.

In this application to GI, the data and information required for this study was collected from primary and secondary sources, using a mixed methods approach (Creswell, 2014). Initially an online search was conducted to identify the key formal and informal stakeholders who manage different types of GI. Document analysis of annual reports, policy/strategy documents, organizational websites and online feedback forums to uncover roles, responsibilities and stances with respect to GI was undertaken. Additional documents were identified by internet search and by requesting relevant policy documents. In-depth interviews were used to untangle the formally reported contextual conditions from the culture and norms of the people in agencies (Brimbank City Council, Melbourne Water, City West Water and Vic Roads). Additional interview participants were recruited by expertise domain (e.g. native vegetation expertise, research/consulting, community, Friends groups, neighbouring council) using a snowball sampling method which is appropriate to a case study. Interviews were conducted with 13 experts and practitioners using a script with questions relating to GI. Questions included (1) professional opinion of the participant with respect to the quantity, quality, utility and ecological value of GI in the council area; (2) community consultation processes of the organisation; (3) extent of collaboration with other stakeholders; and (4) transaction

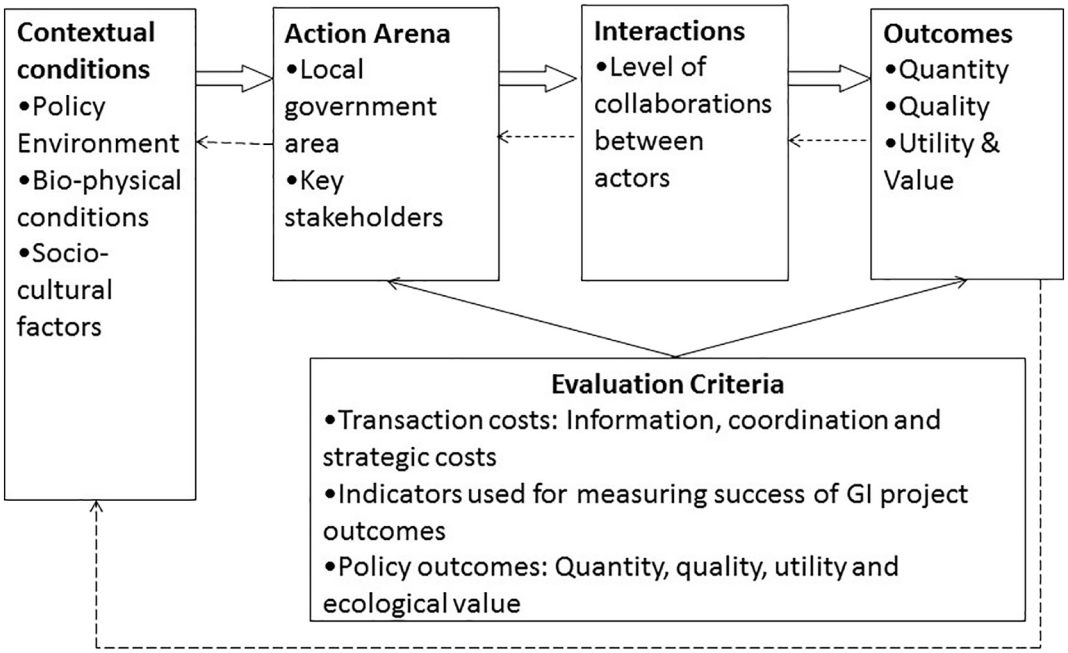

Fig. 1. The Institutional Analysis and Development Framework.
Source: Ostrom (2005) framework - adapted for institutional analysis of GI.

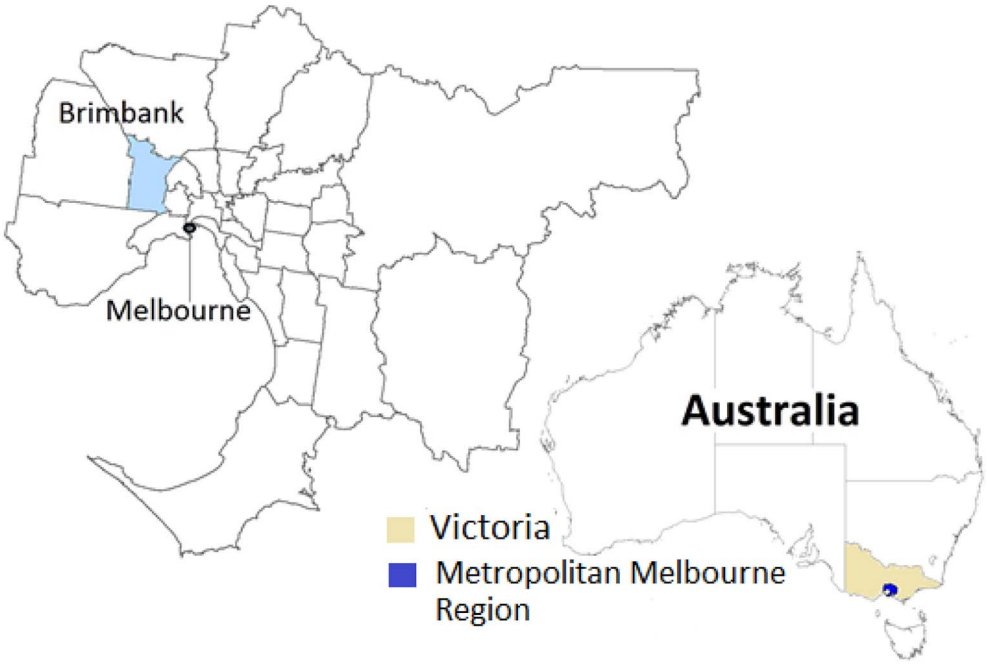

Fig. 2. Brimbank City in the Western suburbs of Metropolitan Melbourne, Victoria, Australia.

costs with respect to GI projects. Memos based on the recordings were coded and used in qualitative research. In addition, as part of a larger project, a community forum (29 people attended) was also held to understand wider views on existing and future GI development, see online supplementary information Supplementary Table 1.

3. Application of IAD Framework to GI

3.1. Contextual Conditions

The key actors in the action arena and the decisions that they make are influenced by largely exogenous contextual conditions. These include – the socio-cultural attributes of the community, the legislative/policy environment and the bio-physical factors such as rainfall and temperature, soil, flora and fauna.

3.1.1. The Area

The case study area, Brimbank City Council (BCC), a local government area is located on the western suburbs of the Melbourne metropolitan area in the Australian state of Victoria (Fig. 2). Temperatures in BCC vary from a minimum of 13 °C to a maximum of 46 °C. The high summer temperatures of the area have an impact on the health of people, especially vulnerable populations. Mean temperatures in this area have increased by 0.4 °C since 1997 in over the 1961–1990 mean with an increase in the number of days above 35 °C, increasing from 8 to 12 days per year. Record high temperatures of 46 °C in the heatwave of 2009 are associated with the 2009 Black Saturday bushfires in Victoria (Loughnan et al., 2009).

High temperatures, a decade of drought conditions and limited surface and groundwater supplies have forced Councils in Victoria to reduce their water use and search for alternative water uses (e.g. recycled water). In 2003–04, efforts to reduce water use by the council resulted in extensive deterioration of open space with dead trees and bare browned-off grass.

The case study area is situated in the Victorian Volcanic Plain which was cleared for agriculture more than a century ago. Remaining native grasslands have been declared critically endangered effective 2008. More than 25 nationally threatened flora and fauna species having been identified (Williams et al., 2005).

3.1.2. Socio-cultural Attributes

BCC is home to approximately 200,000 people with a population density of 1600 persons/km^2 which is greater than Melbourne city with 440 persons/km^2 (ABS, 2011). Key socio-demographic features of this council area are: 23% of population belong to low income households with income less than $600 per week (19% for Greater Melbourne); 19% population has poor health status (self-rated); 23% of the population (those under 5 years and over 65 years of age) is vulnerable to heat extremes; 17% population is categorised as obese and 44% population as physically inactive (ABS, 2011). Approximately 65% of the population in Brimbank area is exposed to health risks from smoking, alcohol, physical inactivity and obesity (ABS, 2011). The Socio-Economic Indexes for Areas (SEIFA) measures the relative level of socio-economic disadvantage using income, educational attainment, unskilled job incidence and unemployment. The SEIFA index for Brimbank indicates a higher level of disadvantage compared to Melbourne.

Brimbank has low levels of volunteerism and citizen engagement (9%), compared to Melbourne at 16% (VEAC, 2011). Census data shows that 6% of residents were born overseas, and 20% arrived in Australia within 5 years prior to 2011. In 2011, 43% of people in the City of Brimbank came from non-English speaking countries with 12.5% reported difficulty speaking English (Melbourne 5%).

Relative to the greater metropolitan Melbourne area, the western suburbs have traditionally had less access to a range of good quality multi-purpose open spaces (EDAW and Sykes Humphreys, 2008). In general, access to high quality GI such as playgrounds/bike tracks are associated with increased physical activity levels of residents living within 1–3 km radius (Maas et al., 2006; Giles-Corti et al., 2005) thereby reducing the risk of type II diabetes and cardio-vascular disease as well as having mental health benefits and increased social cohesiveness (Sullivan et al., 2004). This urban planning problem is not unique to BCC. Inequality in the provision of GI has been explored for US cities (Heynen et al., 2006) and have the links between health, environmental deprivation and income in the UK (Pearce et al., 2010). The urban poor may benefit more from the recreational opportunities of green space as they have fewer options. However casual relationships among these indicators are complex as the potentially endogenous processes are not well understood.

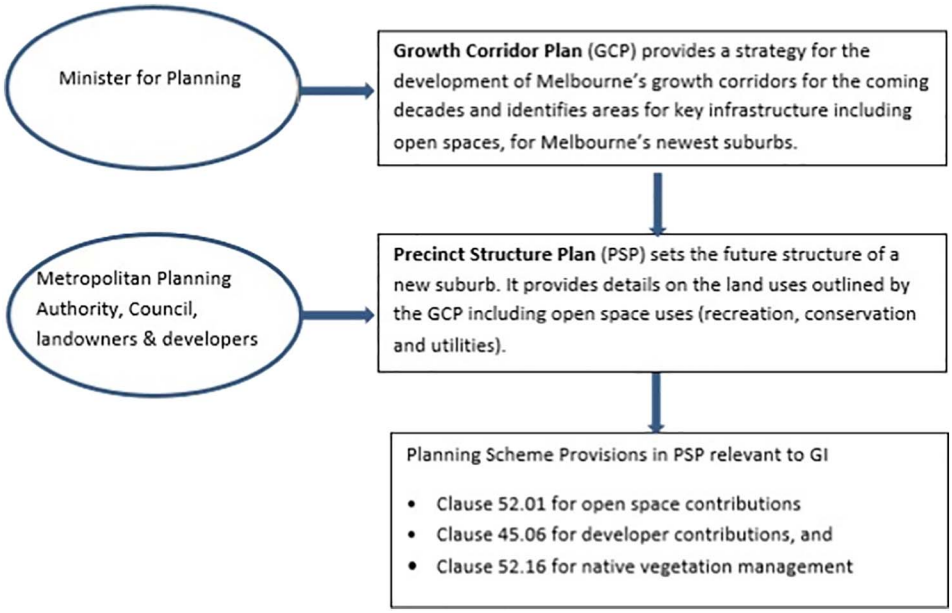
Minister for Planning
Growth Corridor Plan (GCP) provides a strategy for the development of Melbourne's growth corridors for the coming decades and identifies areas for key infrastructure including open spaces, for Melbourne's newest suburbs.
Metropolitan Planning Authority, Council, landowners & developers
Precinct Structure Plan (PSP) sets the future structure of a new suburb. It provides details on the land uses outlined by the GCP including open space uses (recreation, conservation and utilities).
Planning Scheme Provisions in PSP relevant to GI
Clause 52.01 for open space contributions
Clause 45.06 for developer contributions, and
Clause 52.16 for native vegetation management

Fig. 3. Policy provisions for open space planning in Victoria.

3.1.3. Legislative/Policy Environment

Creation and protection of green open spaces is enabled by nested pieces of legislation and planning documents. The Growth Corridor Plan (GCP), approved by the Minister, is a high level plan that provides a strategy for the development of growth corridors for the coming decades identifying areas for open space and other key infrastructure in new suburbs. A Precinct Structure Plan (PSP) prescribes land-use as outlined in the GCP including open space uses (recreation, conservation and utilities). In turn, the PSP is incorporated into local planning guiding the use and development of precinct land and of relevance here, are plans for parks with the intent to guide resolution of accommodating biodiversity, cultural heritage, infrastructure provision and council charges. The process requires the active involvement of landowners, developers, service and infrastructure providers and Councils. However, the Metropolitan Planning Authority (MPA) states that these provisions may be subject to change from time to time depending on changing circumstances (see Fig. 3).

Often, in densely developed areas where land is at a premium, developers pay community infrastructure levy of 5% applied to the site value for residential and commercial developments and 2.5% for industrial developments to the city council. The money collected as infrastructure levy is then used by the council at a later stage to build infrastructure required for community development such as sports pavilions, parks, gardens, community centres etc. The council may, at its discretion accept land in lieu of cash contributions to meet the requirements. In the current case study, BCC currently has ample public open space at the rate of 80m^2/person. However, an analysis of access to green multi-purpose spaces reveals that open space is unevenly distributed, with some areas having very little and of poor quality green space (EDAW and Sykes Humphreys, 2008).

While providing for open spaces through legislation is important, there are additional co-benefits such as ecosystem service values of these open spaces (Gómez-Baggethun and Barton, 2013). Key legislation at the Commonwealth (or federal) and state level to protect the endangered flora and fauna include:

3.1.4. Commonwealth Legislation

- The Environment Protection and Biodiversity Conservation Act 1999

3.1.5. State Legislation

- Flora and Fauna Guarantee Act 1988
- Catchment and Land Protection Act 1994
- Planning and Environment Act 1987
- Wildlife Act 1975
- National Parks Act 1975
- Environmental Effects Act 1978
- Victorian Environmental Assessment Council Act 2001.

The Environment Protection and Biodiversity Conservation (EPBC) Act (1999) is federal legislation which sets out provisions to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. The EPBC Act is of relevance when a proposed development could have a significant impact on a matter of national environmental significance but does not include state regulated issues of air quality, noise, odour, general amenity or animals that are not listed as threatened or endangered under the EPBC Act.

The Flora and Fauna Guarantee Act 1988, state legislation, governs the conservation and management of threatened flora, fauna and ecological communities. It applies to public and private land and establishes a listing process. Once an item is listed, there are a range of administrative and conservation tools that can be used to protect and conserve. However, stakeholders suggest that there is little political will or appetite for protecting native vegetation.

> *We have incredibly good legislation in Victoria – The Flora and Fauna Guarantee Act. It is absolutely brilliant piece of legislation, but the government will not enforce it. It is politically too unpopular. The current Victorian government will try and soften the rules to increase the area that people can clear without having to seek a permit. The government is pro-development and they don't really care.*
>
> An expert on native vegetation

This sentiment echoes the conclusions of 2012 reports from Australian Network of Environmental Defender's Offices (ANEDO, 2014) which suggest that while strong measures exist within existing Victorian legislation, these measures are not used to their full potential. The failings may be occurring as a result of the discretionary nature, enforcement mechanisms and political will (ANEDO, 2014).

In 2013 the Victorian Government altered native vegetation controls, allowing a developer to clear vegetation in exchange for offsets. In theory, offsets enhance economic efficiency while protecting critical habitat if

land of equal or greater ecological value can be set aside elsewhere. However, manmade open spaces may not be equivalent to natural sites.

> *Conservation management in western plains is difficult. It's a difficult terrain with very little rainfall. Historic vegetation form is mostly grassland and people don't value them… Lot of people don't understand the health benefits of greenery. They don't want trees that would damage the house or make it untidy.*
>
> An expert on native vegetation

The State government may in part reflect the position of developers but also the opinion of at least part of the community.

3.1.6. Bio-physical Factors

Bio-physical characteristics such as rainfall, temperature, soil and topography of an area constrain the types of vegetation that can be grown and may have significant impacts on the costs incurred by the different stakeholders in maintaining the quality of GI. The case study area is characterised by heavy soils, low rainfall and high temperatures relative to other parts of the region. This has implications for the cost of maintaining vegetation in public spaces such as parks and sports fields where demand for water is high.

> *with climate change expected to result in lower rainfall patterns in Melbourne in the future, projects that use alternative water sources like stormwater harvesting are the future for urban irrigation.*
>
> Anne Barker, City West Water Managing Director in Pichon (2011)

3.2. Action Arena: Actors and Activities

The key actor and custodian of the public open spaces in this arena is the BCC. BCC establishes, protects and maintains most of the public GI including parks, native grass reserves, street trees, bicycle trails, walking paths and certain aspects of waterways and creek corridors. The waterways, stormwater infrastructure, roadsides, rail corridors and large parks are owned and managed by other actors. BCC attempts to collaborate with each one of them at various levels to achieve various social outcomes. Table 1 presents the key actors, the types of GI managed by them, the strategy or policy document/guidelines followed by them and the activities and outcomes they would like to achieve. In addition to these actors, the Friends Groups[1] play a crucial role in GI management. Friends Groups do not own any of the GI nor are they legally obligated to perform any tasks related to park maintenance or management. They are a group of passionate people who volunteer their time and services to GI management and therefore play a crucial role. There are nine Friends Groups in BCC and their main activities include planting and maintaining native vegetation, raising environmental awareness in the community, and advocacy for protection of endangered flora and fauna. They also actively participate in the community consultations organised by the council and other GI managers.

3.3. Collaborations and Interactions Between Actors

> *We consult and collaborate with other green space managers on various land management issues such as weeds, pest problems and share solutions and ideas. We have good network of people who manage green spaces and we all have informal discussions from time to time. But there are no set protocols or set meetings for this purpose. We don't really have any particular conflict of interests. There is good intention, good will, bit of money and if it's a good enough idea, we can get it done.*
>
> Participant from a neighbouring council office

[1]

Collaboration and links among key actors (resource managers and users) is crucial for successful coordination of policies and the overall robustness of the system (Anderies et al., 2004). Interaction levels among key actors were assessed and classified as “Low”, “Medium” and “High” depending upon the extent of collaboration among actors across areas of mutual interest and jurisdiction. Interactions were classified as high where - actors engage regularly and share resources; medium – actors interact on case by case projects of mutual interest with regular frequency; and low – actors interact rarely and do not pro-actively cooperate.

Table 2 summarises the results of interviews and suggests that according to interview participants that interaction between the key stakeholders is generally low. Efforts to increase collaborations with the other stakeholders has been are described by BCC as “work-in-progress” (Brimbank City Council, 2013). The negative impacts of maintenance programs along rail corridors has improved following the council's consultation with Vic Tracks but maintenance programs undertaken by VicRoads and Parks Victoria are facing challenges due to budgetary constraints. The Friends Groups were positive about BCC and Melbourne Water but were not very positive about other actors.

> *Council is slow to respond to any requests, but they are making changes which I did not expect. VicRoads have multi-million dollar budgets and none for bikers. Sustainability is only on paper. They are non-co-operative. They don't see the bigger picture. Also, with the new federal government, no real money is put into moving people from cars to bikes. It also increases diabetes and obesity. In 20–30 years, you spend lot of money into health care. You have to start with your children walking and biking to school and create a safe environment for them. Taking them in cars gives a false sense of security.*

> *There should be good bike paths along railway easements. The National railway, VT and metropolitan railway are juggling for funds and compete with each other. Bike paths along railway easements can be a very good infrastructure, but VicTrack is not interested. They are very bureaucratic.*

> *Melbourne Water knows what they are doing. Parks Victoria is not useful and difficult to communicate. The Brimbank Park is not what it has been. They have not allocated funding to maintain them. They could improve the bike track up the river, north, but no action has been taken. No one has the vision for it. It is in the interest of Parks Vic to improve it for the 200,000 people, but it is not happening.*
>
> Friends Group participant

The Friends Group participant recognizes the importance of physical activity on health and well-being but there is no involvement of an agency primarily responsible for preventative health schemes in any of the interactions. Councils are required to give consideration to public health and climate in strategic plans according to the *Public Health and Well-Being Act 2008* and the *Climate Change Act 2010*. Follow-up interviews with BCC suggest that there is little interaction specifically on preventative health issues though its importance is acknowledged. Non-governmental organisations such as the Heart Foundation have taken on a social advocacy role at a state and national level to promote policies which balance urban density, green open space and “walkability” (Heart Foundation, 2014).

3.3.1. Community Consultation

> *there is a reasonable amount of community consultation done. But the problem is that the vast majority of the people in the community don't know much about the natural environment.*
>
> Native vegetation and environment expert

Generally, BCC consults the community during the design stage or when major changes to policy are being introduced. Community opinion is sought through: council meetings, community meetings, online complaints and feedback, smart phone app “My Brimbank”, and Brimbank City Council Facebook Page. Community meetings are held at least four to five times a year with participation averaging 15–20

[1] According to Parks Victoria, a Friends Group are people who express an interest in or support a particular park, conservation reserve or species of native flora or fauna. Friends Groups work in partnership with Parks Victoria but are autonomous entities

Table 1
Actors and activities.

	Organisation	Key activities/goals
Brimbank City Council		
Type of GI	Parks, playgrounds, walking paths, natural sites	Establish five district & 25 high quality suburban parks with a good quality playground; establish a series of neighbourhood parks within 500 m or 5–10 min walk for residents with a basic playground shaded by large canopy trees and maintain local reserves, with tree planting and grass areas (Pg 8)
Policy	Creating Better Parks: Brimbank Open Space and Playground Policy and Plan: May 2008	
ES and benefits promoted	Active and passive recreational amenity	
Type of GI	Waterways/Creek corridors	Connect waterway corridors of the Maribyrnong River, Taylors Creek and Kororoit Creek with trails and link them to the surrounding regional open space network (Pg 11)
Policy	Creating Better Parks: Brimbank Open Space and Playground Policy and Plan: May 2008	
ES and benefits promoted	Experience of natural landscape; enhanced connectivity; Corridors for recreation and transport	
Type of GI	Street trees	BCC has approximately 89,000 registered street trees which represent 60% of available planting locations within the City's streets. BCC aspires to increase plantings to 95% by 2030 through tree planting and appropriate management, creating an urban forest oasis. (Pg 7)
Policy	Street Tree Policy, June 2010	
ES and benefits promoted	Cooling benefits; improved air quality; habitat for wildlife	
Type of GI	Bicycle trails and walking paths	The updated Strategy aims to improve walking and cycling rates and outlines 32 strategic network improvements costing approximately $9 million over next 7–10 years (Pg 4)
Policy	Brimbank Cycling and Walking Strategy, August 2016	
ES and benefits promoted	Health benefits; improved air quality; improved access to services; cohesive community	
Melbourne Water		
Type of GI	Waterways, adjoining flood plains & retarding basins	Maintain waterways in their natural physical form; eliminate/reduce litter; provide clear sensory access to water (see and hear water); provide facilities like paths, benches, toilets and BBQ; plant and maintain abundant and healthy looking vegetation that provides micro-cooling and supports native birds and animals (Pg 52, 54)
Policy	Healthy Waterways Strategy 2013 to 2018	
ES and Benefits promoted	Promote recreation, amenity, flood protection, cultural and heritage values	
Type of GI	Stormwater and its infrastructure	Implement integrated stormwater management solutions by maintaining and building stormwater treatment assets and utilise stormwater for irrigating open spaces and streetscape vegetation; reduce risk of flooding (Pg 1)
Policy	Stormwater Strategy 2013 to 2018	
ES and Benefits promoted	Healthy waterways and bays for community wellbeing, amenity, public safety	
Parks Victoria		
Type of GI	Organ Pipes National Park, Brimbank Park, Derrimut Grasslands, Andersons Swamp, Mt. Derrimut Grasslands, Angliss Grasslands	Protect park and waterway ecosystems; maintain cultural heritage in parks; provide opportunities for people to use their parks and waterways; prepare for, respond to and recover from fire and other emergencies; manage public land in conjunction with the community (Pg 8–11: Parks Victoria, 2013).
Policy	Conservation Reserves Management Strategy 2003 Heritage Management Strategy 2003 Indigenous Partnership Strategy and Action Plan 2005 Linking People and Spaces 2002	
ES and Benefits promoted	Environmental, cultural and heritage values; acknowledge traditional Aboriginal owners	
VicRoads		
Type of GI	Roadsides	Develop roadside asset management plans in consultation with communities; fund programs that ensure road safety; preserve community assets; cost-effective asset management for immediate and long term environmental, social and economic outcomes (Pg 47, 64, 231).
Policy	Road Management Act 2004	
ES and Benefits promoted	Road safety and vehicle movement; cultural heritage values; fire risk reduction; Roadside amenity	
Type of GI	Roadsides	Manage road network to minimise greenhouse gas emissions; avoid, minimise and offset biodiversity, heritage and water resource impacts; demonstrate best practice on sustainability and climate change issues (Pg 6).
Policy	Sustainability and Climate Change Strategy 2010–2015	
ES and Benefits promoted	Natural and cultural environment; sustainability	
Vic Track		
Type of GI	Rail corridors and Rail reserves	Provide an integrated, cost-effective approach to managing vegetation along rail corridors through routine weed control and fire management (Pg 36, 58).
Policy	Vegetation Management guidelines for rail corridors https://www.yumpu.com/en/document/view/11799493/vegetation-management-guidelines-for-rail-corridors-victrack	
ES and Benefits promoted	Biodiversity, aesthetics; cultural	

Table 2
Extent of interactions among actors.

	Brimbank City Council	Melbourne Water	Parks Victoria	VicRoads	Vic Tracks	Friends Groups
Brimbank City Council	–	Medium	Medium	Low	Low	High
Melbourne Water	Medium	–	None	Low	None	Medium
Parks Victoria	Medium	None	–	Low	None	Medium
VicRoads	Low	None	None	–	None	None
Vic Tracks	Low	None	None	Low	–	Low
Friends Groups	High	Medium	Medium	None	None	–

people depending on place and type of project. Usually semi-retired adults who are also members of the Friends Groups attend these meetings. The level of public consultation by other key actors such as VicRoads, Vic Track and Parks Victoria except Melbourne Water with respect to GI projects was generally found to be low with limited engagement. Public consultations by Melbourne Water were rated

Table 3
Transaction costs associated GI projects.

Information costs	Coordination costs	Strategic costs
Brimbank City Council		
Low Costs incurred during preliminary investigation are low. However they can increase with the scale and type of the project	Low Information and coordination costs together cost 8–10%	Medium to High Strategic costs can be high for rivers and heritage sites. If asbestos contamination is found on a site, EPA approval is required and clean-up can cost $100,000–150,000 and up to one year timeframe. For lands belonging to Vic Tracks and VicRoads, approval takes 2–3 years. If land belongs to a third party, time will vary.
Melbourne Water		
Low Includes costs of investigations from within the organisation and from public agencies	Low Semi-formal discussions between collaborating agencies	Low Melbourne Water as the apex body in the State for water supply and management, makes decisions about GI and implements them
VicRoads		
Low Includes staff time and system maintenance costs	Medium Includes staff time meetings, consultations with other partners	Very High Staff time, preparation of strategy

'medium' by the Friends Groups (See Table 2).

3.3.2. Transaction Costs

The success of inter-organizational policy implementation is determined in part by policy design and by transaction costs. Imperial (1999) suggests three types of inter-related transaction costs – information costs (result of searching for and organizing information), coordination costs (sum of the costs incurred as part of negotiation, monitoring, and enforcement of agreements underpinning a resource management plan), and strategic costs (which result from the usual sorts of asymmetries in information or power that result in free-riding and rent-seeking behaviours). As part of the interviews, participants were asked to rank transaction costs incurred by their organisations with respect to GI projects as very low, low, medium, high or very high.

Across Table 3, transaction costs were variable. Low transaction costs can indicate harmonious interactions or efficient interactions among actors. However, in this case low transaction costs are also indicative of limited engagement with the community and other actors.

As an example of transaction costs, community groups have opposed developments through civil court actions (e.g. Brimbank Public Land Action Group Inc. v Brimbank CC [2007] VCAT 434) which have sought to modify development, protect native vegetation, and enhance recreation values through walking/bike paths. Recently residents have mounted objections to the sale of parks as part of statutory consultation periods (e.g. Lucas, 2015) and through occupation of these spaces.

4. Discussion

Thirteen interviews were conducted, recorded and analysed with the stakeholders. Follow-on document analysis reveals a patchwork of results in terms of the quantity, quality, utility and ecological value of the various GI managed by the key actors (see Table 4).

On a per capita basis, there is sufficient open space across the City of Brimbank with an undersupply in some areas (EDAW and Sykes Humphreys, 2008) but a significant gap exists in terms of the extent and quality of playgrounds. Further, the quality of the parks is in transition. Out of the 230 parks highlighted for upgrade as part of its 10 year programme of improvements, BCC has upgraded 77 parks and constructed 15 km of new trails described as "very good". Kilometres of bike paths are increasing and provide opportunity for increasing physical activity in the community. Many of the existing parks remain inadequate. Attempts by BCC to sell open spaces to raise revenue has met with community resistance.

Natural reserves were generally found to be inadequate.

> *If you go back 25 years ago, there was no interest in natural environment in any of the councils. There was not a single person employed to take care of the environment. They just mowed the grass and made things look neat. There was no understanding of the value of what was there. They may over time improve their value by putting resources into weeding, but they have gone far too down the track to restore any of those sights to the pristine condition that they were in. And that's a reality. If they put no resources, in 20–30 years, there will be no value left. Effective management by people with environmental skills is needed. You don't want the parks and gardens department managing them……you need people with different mindset and you have to train the people. They are usually interested in visual amenity which essentially revolves around pruning and mowing the grass.*
>
> Native vegetation and environment expert

BCC identified native grassland rehabilitation and maintenance of urban trees as a priority. Native grassland management in the western plains of Melbourne has been largely unsuccessful (Williams et al., 2005; Gott et al., 2015). Interviews with BCC officials reveal the need for new legislation for managing trees on private land, especially large old trees with ecological value for nesting birds.

Damage through mowing, spraying and burning has occurred because of limited communication between local government (BCC) who is responsible for protecting native grassland and those performing maintenance (VicRoads). The privatisation of Victorian rail lines and the employment of private contractors (who have limited knowledge of native grasslands) to undertake maintenance of lines has exacerbated the degradation of several important sites (Williams et al., 2005). In terms of tree planting and maintenance, Council is promoting a mixture of native (more) and non-native trees (less) in public open spaces to improve ecological value e.g. through infill tree-planting.

> *Brimbank has several small remnants of grasslands, but they are in relatively poor condition… the environment department of the council is putting in a lot of resources into them, but poor management practices in the past have severely damaged them. Most of the sites are surrounded by houses and the area is too small to accommodate the large population of birds and animals.*
>
> Native vegetation and environment expert

Roadsides rank poorly across all criteria. According to the interviews, roadside maintenance is a low priority for VicRoads. However, the recently released 'Plan Melbourne-Metropolitan planning strategy 2017–2050' places emphasis on boulevards and roadsides. Finally, the quality of waterways and the wetlands across this area is poor but improving. The waterways (Maribyrnong River, Kororoit and Skeleton

Table 4
Policy Outcomes for different type of GI in the Brimbank City Council.

GI	1. Quantity		2. Quality		3. Utility		4. Benefit or ecological value	
	Measure	Rated by respondents	Measure	Rated by respondent interviewed from the respective organisation	Measure	Rated by respondents	Measure	Rated by respondents
1. Parks (BCC)	Area under parks in proportion to the population of the council	Very Good	Well maintained vegetation, facilities in the parks such as play equipment, benches, toilets, shady trees, safety aspects	Variable[a]	Enough facilities in the park to cater to different age groups and population of the locality	Variable[a]	Does the space support native flora and fauna and perform other ecosystem services such as reducing storm water run-off, soil erosion and cooling benefits	Inadequate[b]
2. Bike paths (BrimBUG Friends group)	Kilometres of bike paths	Adequate	Condition of the paths and whether they connect to the crucial amenities	Good	Are the paths well positioned with easy access and connecting people to public transport, business, shopping centres and other amenities.	Very Good	Do they support ecosystem services such as reducing carbon emissions and improving health of the community by providing physical exercise.	Very Good
3. Natural reserves (BCC)	Area under natural reserves	Inadequate	Extent of native flora and fauna in the reserves and free of weeds and pests	Inadequate	Contributes to the health and knowledge of the community	Inadequate	Does the space support native flora and fauna and perform other ecosystem services such as reduces storm water run-off, soil erosion and cools down the area in summers	Inadequate
4. Roadsides (VicRoads)	Are they wide enough and have vegetation	Inadequate	How well is the vegetation on the roadsides maintained	Inadequate	Inadequate	Inadequate	The spaces support native flora and fauna; the trees provide cooling benefits	Inadequate
5. Waterways, flood plains and land along waterways (Melbourne Water)	Length of waterways, whether they retain water through the year	Inadequate	Quality of the water as per the standards of Melbourne Water	Inadequate	Provide recreational value to community	Inadequate	Support native flora and fauna; prevent flooding in the area; provide cooling benefits	Inadequate

Note: The indicators are cited under the column heading 'Measure' in columns 2, 4, 6 & 8. The 'quantity, quality, utility and Benefit/Ecological value' (see row 1) of the respective GI (see column 1) is measure by the respective organisations (see brackets in column 1) responsible for them except, bike paths which was rated by BrimBUG (Brimbank Bike Users Group, a Friends Group).

[a] "Inadequate to Adequate" for 160 existing parks. 'Very Good' for the 70 renovated parks.

[b] Inadequate for small parks and reserves.

creeks) and groundwater resources have been contaminated by poor industrial and land use practices in the past. Although these practices have stopped, the contaminants still impact on the receiving waters and according to the EPA, may not have peaked (EPA Victoria and Melbourne Water, 2009). An analysis of the data collected over 2005 to 2010 shows that, of the rivers and creeks in Melbourne region: 20% are in good or excellent condition; 41% are in moderate to poor condition; 36% are in poor or very poor condition (Melbourne Water, 2013). Even though Melbourne Water emphasises amenity value when managing their green spaces, the priority over the next five years, will be to reconcile amenity values with ecological and conservation values and connect reserves, plant more trees and create a buffer between waterways and public areas.

> *Increasing the connectivity between the nature reserves will enhance the habitat values. Secondly, we need to increase resilience, the "edge effect" – the smaller the reserve is, the greater the ratio of its edge to its area, the more vulnerable it is to decline. You want things to be connected, so if you have a little reserve, that is connected to another one here, that's one boundary where the weeds can't come in, because the other reserve is weed free as well. But we have all these places in Brimbank that are protected, and it's a wonderful thing that they are protected, they are fenced natural areas of vegetation that we fought for, but they are just little isolated things. There is so much from the ecological processes that's missing, all the little mammals that used to dig, are no longer there, there's been use of chemical fertilisers and pesticides, so the soil composition has changed, so many species have disappeared, the rabbits are eating everything that's tasty under the ground, if we don't have the place fenced off. The very least we can do is to join up the habitat.*
>
> Expert in waterways management

4.1. Increasing Expenditure of the Council on GI

BCC has increased spending on maintenance and upgrading of its GI (see Fig. 4) with a 181% increase in spending on parks and open spaces between 2002 and 2014. This action was required to mitigate the impact of previous decisions to cut water use by 40% by reducing the irrigation of parks, sports fields and other as part of the Council's Water Conservation Action Plan. As a result of this water conservation decision, green spaces deteriorated. Community opinion, reflected in surveys (e.g. Brimbank Annual Report, BCC 2004–05), indicated that the water conservation measures had gone too far.

In response, BCC formed a new internal Environment Department with budget and extra staff to develop an Environment Plan. Concurrent with this recognition of the impact of restricting irrigation, there was a high level of new residential and commercial property development. Developers made substantial contributions to BCC for infrastructure development including parks and other green spaces (Brimbank Annual Report, 2003–04) supporting investments in GI. A further action included 'Creating Better Parks - Open Space and Playground Policy and Plan' (May 2008) which was a significant step forwards in improving BCC's green spaces. Financial resources from levies and a shift in priorities marked a major change in the way GI was managed.

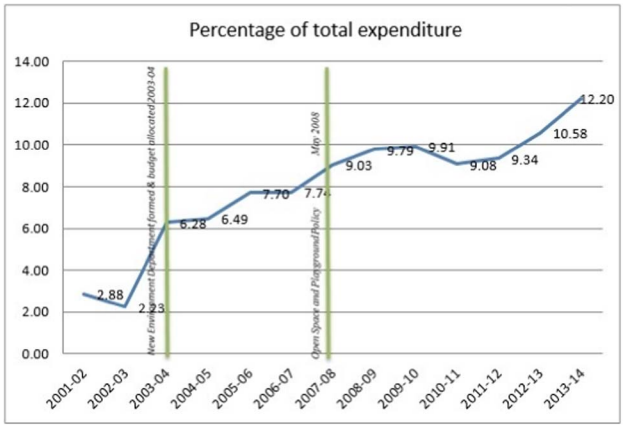

Fig. 4. BCC spending on maintenance and upgrading of its GI.

4.2. Performance Indicators used to Assess GI

A performance indicator should be well-defined, informative, refer to a result that is directly under the control of the organisation and comparable with a benchmark or comparable to a previous result over time (ACT Government, 2013). Pakzad and Osmond (2016) developed a conceptual framework for evaluating GI performance based on their research in Australia and abroad. The framework links GI performance to ecosystem services, ecosystem health and human health and well-being. Thirty indicators including both qualitative and quantitative variables, have been developed including ecological, health, socio-cultural and economic indicators. All of these indicators can potentially be used as measures to assess the performance of the various stakeholders/organisations managing GI.

Available output indicators used by the stakeholders in the current case study were accessed to evaluate the success of particular projects or activities with success being defined as progress towards some strategic goals or fulfilling certain pre-determined targets in Table 5. However, using these indicators for assessing different ecosystem services (i.e., provisioning, cultural, habitat support and regulating) proved difficult with these indicators either because they were qualitative in nature or because of varying frequency and non-uniformity in what was being measured. The indicators used by the stakeholders (Table 5) when compared with the indicators suggested by Pakzad and Osmond (2016), were found to be grossly inadequate for the task of predicting ecological outcomes of new developments and cannot serve as planning tools. Specific indicators for health and well-being of community residents are also limited with only coarse indicators such as park visitation and bicycle use.

According to Ruppert (2015), when data collected by government agencies is made public and transparent, it allows citizens to hold government organisations accountable, informs public service investment choices and provides feedback for innovation and growth. However, in the current case study, raw data that might be used to develop the ecological indicators are collected by different agencies and often not shared publicly, making it difficult to collate and derive meaningful estimates to inform the development or maintenance of different GI components. Developing fit-for-purpose indicators with stakeholders represents a means of forming a baseline from which to measure and evaluate progress. Further the process of developing indicators "should be empowering in itself" (Hernandez-Morcillo et al., 2013, p.436).

5. Conclusions and Future Directions

The institutional analysis identified some crucial factors that have implications for decision-making and ultimately outcomes. The current approach to council area planning, public land management, water and infrastructure, is decentralised and loosely co-ordinated, a feature common across many jurisdictions. Resource management decisions related to GI are spread among different actors who have their own responsibilities, agendas and budget priorities. Increased spending by BCC on parks and reserves has enhanced amenity and recreational values. However the full suite of benefits of GI that feature in strategy statements are not systematically evaluated in terms of outcomes. For instance, the analysis identifies opportunities associated with creating corridors of vegetation which could increase habitat value of open spaces. Providing for bike paths in railway corridors and walkable areas

Table 5
Indicators used by actors to measure success of their investments/projects undertaken in the year.

Ecosystem services	Indicators
Brimbank City Council (BCC Annual Report 2013)	
Recreation/social benefits	• Percentage increase park visitation • Budget spent on parks and open spaces • Number of trees planted; new park upgrades; fences removed to encourage greater use by community; bicycles counted during Bicycling Network Victoria's super Tuesday
VicRoads (VicRoads Annual Report 2012; 2013)	
Biodiversity values of roadsides	• Percentage increase in banking of native vegetation and threatened species offsets • Number of fauna crossings; bio-links • Permitted native vegetation removal versus vegetation offsets purchased measured in 'habitat hectares' and 'large old trees'
Cultural heritage	• Installation of cultural heritage signs
Melbourne Water (Melbourne Water Annual Report 2013)	
Environmental values	• Water quality indicators: temperature, pH, dissolved oxygen, salinity, nutrients, metals, faecal contamination • Habitat area which supports a diversity and abundance of plants and animals • River flow patterns • Connectivity of waterways allowing movement of birds and animals • Physical shape of the river
Parks Victoria (2013)	
Recreational and biodiversity values	• Number of hectares treated to minimise the impact of pests in parks (ha) • Visits to parks • Percentage of downstream assets rated in average to excellent condition; park assets rated in average to excellent condition • Total cost ($) and area of estate managed by Parks Victoria (ha)
Department of Environment and Primary Industries (DEPI Annual Report 2013)	
Biodiversity and environmental values	• Number of native vegetation credit trading agreements signed through BushBroker program • Number of environmental condition research reports, improvement tools, guidelines, policies, systems and plans completed and issued • Percentage increase in EPA notices issued for illegal dumping of waste; hours during which air quality standards were met as a proportion of hours in the reporting cycle; land audits submitted; pollution incident reports acted upon within three days
Vic Track (Vic Track Annual Report 2013)	
Environmental values	Number of contaminated land assessments to identify potential environmental or health risks resulting from historical land use or poor management practices

with vegetation for shading, hold potential for preventative health benefits. Low interaction among the transport agencies and most of the other actors such as Melbourne Water and Parks Victoria may be contributing to this outcome. BCC does recognise this and in the recent years, it is working in collaboration with its community, City West Water, Melbourne Water and the Office of Living Victoria, to implement strategies to reduce potable water use, increase use of alternative water sources such as stormwater and reduce pollutants entering waterways using infiltration trenches and bio-retention systems such as raingardens (BCC, 2016, p.3). In 2014/15, Council's stormwater water harvesting systems saved over 100 ml of potable water (BCC, 2016). Coordinated efforts to increase the use of alternative sources of water could aid in recovery and maintenance of trees and vegetative cover. Future research in GI could focus on better nesting of responsibilities and governance structures (Garrick et al., 2012; Marshall, 2008) to capture the benefits of greater co-ordination and targeting of resources.

The low level of interactions and lack of constructive collaboration among the various actors results in frustration of the dedicated volunteers. The recent shift in the government's focus, both at Commonwealth and state levels, away from environmental protection to grey infrastructure projects such as roads and by-passes suggests road safety and travel time are central considerations. Benefits of GI could become increasingly peripheral to the main agenda of State and Commonwealth governments.

Biophysical factors (temperature and rainfall) may define in part the scope, type and nature of green spaces, where social-ecological systems interact. In the current case, high temperatures and low rainfall has forced the council and the water authorities to collaborate and design alternate water sources for irrigation of green spaces. Poor quality of the green spaces in 2003–04, due to sustained drought conditions and water restrictions, motivated strong public sentiment and forced the council to re-evaluate their investments in GI and look for alternative water sources.

Legislation around urban land use planning supports in principle GI and open spaces, but when it comes to competing priorities between environment and development, it is the view of interview participants that development is favoured over the long-term impacts of human wellbeing.

This suggests the ongoing need for council to work with the community to protect these areas and avoid the high transaction costs associated with contested development.

The gap in performance indicators for health and well-being and critical biodiversity values suggests that the capacity of the local government may have been exceeded. Reviewing institutional arrangements with a subsidiarity lens to the appropriate level of government agency may help to clarify the arenas for credible cooperation (Zurita et al., 2015) especially with respect to environmental values such as endangered grassland habitat. However, the need for state or Commonwealth agency may still be required where fiscal capacity or practical feasibility or legislative authority is exceeded.

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